Reetik Kumar Sahu

CONTACT INFORMATION

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SUMMARY

Expertise in building optimization and machine learning based frameworks for environmental sustainability problems. With a background in optimization, game theory and decision-making under uncertainty I construct decision-analysis models for food-energy-water nexus and common pool problems to assess water scarcity and identify pathways to improve resource sustainability.

SKILLS

Water Resources Management, Machine Learning, Optimal Control, Game Theory, Decision-making under uncertainty, Stochastic Optimization, Numerical Methods

RESEARCH EXPERIENCE

Hydroeconomic modeling to improve water security
Water Security Research Group, IIASA *Research Scholar, Dec 2020 - present*
Currently involved in multiple research projects that focus on developing hydro-economic optimization methods for spatially explicit solutions in water resources management issues, applying machine learning in hydrology and developing methodological framework to assess water security.

Current projects:

- *The World Bank ECA Regional Water Security Initiative*:
  Assess and benchmark current and future challenges around water security in the Europe and Central Asia (ECA) region; and, to develop an operational Methodological Framework to conduct country and regional Water Security Assessments and Benchmarking as well as to provide country specific recommendations using an Action Planning Tool.
- *Climate change induced waterstress: challenges and opportunities in Austrian regions*:
  Assess water availability and demand in Austrian regions considering alternative socio-economic and climate futures. This is to understand the risk of water stress and associated management opportunities.
- Supervising doctoral students selected under IIASA Young Scientists Summer Program (YSSP)

Water Energy Decision Support using Machine learning
Supervisor: Juliane Mueller, Berkeley National Laboratory *Postdoc, Nov 2018 - Nov 2020*
This project focuses on building data-driven surrogate models using Machine learning to emulate groundwater flow in a watershed. As part of the Sustainable Groundwater Management Act in California, the project builds a decision framework for Groundwater Sustainability Managers to build resilient water management strategies

- Assess risks of future climate scenarios
- Joint project between the Computational Sciences, Data Sciences and the Geosciences group
- Funded by Laboratory Directed Research and Development at Berkeley Lab

Multi-Agent Real-time decision making in Water Resources Systems
Advisor: Prof. Dennis B.McLaughlin, MIT *Ph.D Project, Sep 2015 - August, 2018*
This research focuses on the numerical implementation of dynamic optimization techniques for single and multiple-agent control problems. Building frameworks to permit the use of more realistic description of the physical system that provide a better qualitative insight for decision making. With concepts from optimal control and differential game theory, two real-time decision-making problems are solved:

- Modeling groundwater pumping as a multi-agent groundwater common pool resource (CPR) problem incorporating the strategic effect of competition and aquifer dynamics
  - Obtain conditions for investment into management institutions or water markets
  - Joint collaboration with MIT economics department
  - Funded by MIT Environmental Solutions Initiative
- Developing a coupled framework for determining hydropower contract and real-time operating rules for single agent reservoir operations problem.

Optimal Reservoir Operation with Predictive Control
Advisor: Prof. Dennis B.McLaughlin, MIT *S.M Project, Aug 2013 - June 2016*
This project involves using Model Predictive Control (MPC) to optimize the operation of a hydro-reservoir for generating reliable hydro-power. The reservoir takes into account several competing objectives like revenue generation, environmental impacts and changing economic conditions. The work provides an insight into the impacts of energy generation for different stakeholders and suggest ways to design facilities and operating policies.

Parameter Estimation using Markov chain Monte Carlo class of Algorithms
Advisor: Prof. C. Balaji, IIT- Madras *Thesis project, May 2012 - June 2013*
This project was a part of an Indian government funded project, 'Swarnajayanti' to improve weather forecasting and cyclone tracking using satellite data. My work involved using Monte Carlo techniques like Hybrid Monte Carlo algorithm for parameter estimation in heat transfer problems and retrieval of atmospheric parameters.

RESEARCH

Journal Papers

- *Hydrological Concept Formation inside Long Short-Term Memory (LSTM) networks*, Thomas Lees et. al. *Hydrology and Earth System Sciences*, 2022
- *Assimilation of multi-channel radiances in mesoscale models with an ensemble technique to improve track forecasts of Tropical cyclones*, R Chandrashekhar, Sahu. R.K., Balaji. C. *Journal of Earth System Sciences*, 2022
- *The Multi-scale dynamics of Groundwater Depletion*, Sahu R.K, McLaughlin. Dennis, *Water Resources Research*, 2021
- *Impact of Input Feature Selection on Groundwater Level Prediction from a Multi-Layer Perceptron Neural Network*. Sahu, R. K., Mueller, J., Park, J., Varadharajan, C., Arora, B., Faybishenko, B., Agarwal, D. *Frontiers in Water*, 2020.
- *Surrogate Optimization of Deep Neural Networks for Groundwater Predictions*, Mueller J., Park J., Sahu, R.K., Varadharajan C., Arora B., Faybishenko B., Agarwal D. . *Journal of Global Optimization*, 2020
- *An Ensemble Optimization Framework for Coupled Design of Hydropower Contracts and Real-Time Reservoir Operating Rules*, Sahu R.K., McLaughlin D., *Water Resources Research*, 2018
- *Application of Hybrid Monte Carlo algorithm in heat transfer*, Sahu. R.K., B. Konda Reddy, C. Balaji, *ASME Journal of Heat Transfer*, 2017
- *Long term Gap filling of Time Series using Deep Neural Networks*, J., Park, Sahu, R. K., Mller, J., Varadharajan, C., Arora, B., Faybishenko, B., Agarwal, D. (in preparation)

EDUCATION

Massachusetts Institute of Technology, Cambridge MA, 2015-2018
Doctor of Philosophy (Ph.D.) in Computational Science for Resource Engineering
Department of Civil and Environmental Engineering

Massachusetts Institute of Technology, Cambridge MA, 2013-2016
Master of Science in Computation in Design and Optimization (CDO)

Indian Institute of Technology Madras, Chennai, India 2008-2013
Bachelor of Technology in Mechanical Engineering
Master of Technology in Energy Technology